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ABSTRACT

The first (exploratory) phase of the Learning in Science Project (Primary)--LISP(P)--focused on science teaching/learning in New Zealand primary schools. Previous information about science teaching/learning was obtained from interviews with children, teachers, principals, science advisers, teachers' college lecturers, and inspectors. To gain additional insights, observations and audiotape recordings were made of six science lessons taught by four experienced teachers; about 90 students aged 5- to 11-years-old were observed during approximately 3 hours of science instruction. The intent is not to give an entirely balanced view of good or bad learning, but rather to clarify difficulties in teaching and learning science. Results are presented and discussed in two sections. The first section focuses on six issues relating to teachers teaching science, such as teacher-centered lessons and teachers assuming that students' meanings for words were correct. The second section, which focuses on children learning science, examines issues related to children's: questions, communicating ideas, changing ideas, understanding things, answering strategies for teachers' questions, and strategies when doing activities. One conclusion noted (which supports previous data) is that teachers perceive their role in primary science teaching as one of transmitting knowledge to children. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

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PRIMARY SCIENCE: A VIEW OF THE CLASSROOM

Science Education Research Unit
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Hamilton, N.Z.

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2 Working Paper No. 103

PRIMARY SCIENCE: A VIEW OF THE CLASSROOM

Fred Biddulph

October 1982

A Working Paper of the Learning in Science Project (Primary)

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INTRODUCTION

This study forms part of the exploratory phase of the Learning in Science Project (Primary). To date, information about the learning and teaching of science in primary school classrooms in New Zealand has come from interviews with a number of children, teachers, principals, science advisers, teachers' college lecturers and inspectors (Biddulph, 1982). To gain additional insights six lessons taken by four experienced teachers in three New Zealand schools were observed during June/July 1982 (see Table 1).

Table 1: Primary Science Lessons Observed[1]

CLASS	TOPIC	CHILDREN OBSERVED
J.1	Bones	whole class
S.1	Liquids	class and group
S.3	Rocks	class and group
S.3	Rocks	class and group
S.4	Pulleys	one group
S.4	Water	one group

In all, about 90 children aged 5-11 years were observed during approximately three hours of science lessons. The two S.3 lessons were taken by the same teacher and the two S.4 lessons were also taken by one teacher. Explicit verbal direction of the lessons by the teacher ranged from continuous throughout in the case of the junior school lesson on bones, where the children sat in a circle on the mat the whole time, to very little in the case of the S.4 lessons on pulleys and water, where the teacher joined each group only three or four times during the lessons and then for only a minute or so at a time. In the lessons on liquids and rocks the teachers provided strong direction during the whole class phases of the lessons but less direct guidance during the group-work phases.

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[1] J.1 pupils are aged 5 years, S.1 aged 7 years, ..., S.4 aged 10 years.

All the lessons observed, although not all the teacher-children verbal interaction that occurred during the group-work phases were audio-taped, and observations made during the lesson were noted. This paper is based on those observation notes, on an analysis of the transcripts derived from the tapes of those lessons, and on some additional transcript material obtained from two groups of S.3/4 children when a member of the Learning in Science Project team took a special lesson in a classroom on the bark of trees (Symington, Osborne, Biddulph and Freyberg, 1982).

This report is not meant to be evaluative, nor does it purport to give an entirely balanced view of good or bad learning. Rather our emphasis has been to attempt to clarify difficulties in the teaching and learning of science in the primary school. Issues relating to teachers teaching science are considered first. The second part of the paper is given to a consideration of children learning science.

TEACHERS TEACHING SCIENCE

It is no reflection on New Zealand primary teachers that most of them lack a background in science, including a lack of knowledge of various science teaching models, and therefore rely heavily on the Education Department Infant - Std. 4 science units to teach from. It is perhaps also understandable that teachers tend to perceive their role as one of involving children in various activities in order to get certain knowledge across to them (Biddulph, 1982a). Some idea of what this means in practice can be gained from the following observations of experienced and sympathetic teachers taking science.

1. Lessons Were Based on Ideas, Problems and Questions Provided by the Teacher

From the observations, it seemed to the observer that each of the six lessons was based on ideas, problems or questions provided by the teacher. The teacher who took the lesson on bones, for example, had acquired raw

bones from a butcher and she worked toward teaching the children about ligaments. The group of children involved in the activity using pulleys said that they had been asked by their teacher to find out whether a particular load was easier to move using an arrangement of pulleys shown in a picture in a booklet. For two of the lessons the teacher questions or requirements had been written on cards to direct the children's activities. Two questions from the lesson card on liquids, for example, were:

"Is it thick or thin?" "Can you see through it?"

The teachers were therefore guiding the children in what to do during the lessons but they were not necessarily helping them understand the purpose of activities, except in one observed instance during a lesson on rocks when the teacher asked,

"Have you got some thought as to why we might be doing this?"
(S.3 teacher)

The consequence of this question was that the children began predicting what would happen to the rocks during the planned activity instead of trying to decide why they were engaging in the activity and at the point where the teacher said,

"Okay, right, we'll do it."

the teacher's intended purpose still did not appear to have been made explicit to the children.

The dominance of teachers in choosing the problem to be investigated, the activities to investigate the problem, and even the conclusion to be drawn from the study, and a corresponding lack of transfer of the problem, the activity and the conclusions to the pupils has already been noted at the Form 1-4 level (Tasker, 1981).

2. First-Hand Experiences Were Provided to Help Answer Teacher Posed Questions, not Pupil Posed Questions

In each of the six lessons, the teacher provided all the observed children with opportunities to be involved in some 'hands-on' task. The children handled bones, touched liquids, threaded pulleys and immersed

sandstone in water, among other things. The amount of time individual children engaged in these experiences ranged from a few minutes with the bones to the whole lesson of half-an-hour or so in the case of the water and pulleys. Only on one occasion, however, did the observer see first-hand experience provided in response to children verbally seeking knowledge. During the lesson on bones one boy asked the teacher about the ligament.

> "Can you break it?"

and the teacher replied,

> "Well, I'll put it on the table and Mark, you can have a try at breaking it."
>
> (J.1 teacher)

3. <u>There Was Little Real Linking of New Knowledge to the Ideas Already Held by Children</u>

The teachers used a number of ways to try to convey knowledge to the children, including their own and other children's explanations, but there were just two observed instances where one of the four teachers obviously tried to help the children build up new knowledge through linking it to what they might already know. Both instances had to do with sediment. As an example, when the teacher was introducing the word sediment in the context of a study of rocks, he tried to establish the meaning of the work by asking the children to recall instances.

> "Anybody know anything about sediment? Heard the word 'sediment' before? Where would we perhaps find anything to do with sediment?"
>
> (S.3 teacher)

4. <u>Various Cuing Strategies Enabled the Teacher to Obtain the Answer Required in a Question Session</u>

Ball (1980) refers to the fact that a teacher gives out cues to children by style of speech, accent and tone of voice, gestures, facial expression and so forth the moment he or she walks into the classroom. Donaldson (1978) also describes how contextual cues have significance for children in that children respond not so much to the words used by a teacher but to what they think the teacher intends.

During the lessons observed, two of the teachers with good intentions and possibly subconsciously used various techniques to shape the children's responses so that eventually predetermined answers were obtained. Four main cuing strategies were used in this respect.

(a) Sentence-completion cue and word-completion cue: On six occasions the teachers cued the children toward the required answer by making a statement that had the final phrase, word or portion of a word missing. During the lesson on bones, for example, the name 'vertebra' arose and the teacher asked where the vertebra is found. When one child said,

"In your neck."

the teacher responded,

"In your neck and down your ..."

(J.1 teacher)

Likewise, during one of the lessons on rocks, Tongariro was mentioned as a place where igneous rocks would be found. The teacher asked where Tongariro is and after the children had guessed "in New Zealand somewhere", "in Auckland", "in Taranaki", he replied to the last child who had said "Taranaki",

"Ah, no, you're thinking of that one old boy (points to 'Mt Egmont' written on board). Right, well down around ..."

(S.3 teacher)

One teacher used a sentence-completion cue in conjunction with a word-completion cue.

Teacher: "Stretchy things called ... (waiting for response, but none). Lig... (offering cue)."

Child: "Lig."

Teacher: "Liga..."

Several Children: "Liga."

One Child: "Ligamin."

Teacher: "Ligament, that's right."

(J.1 teacher and children)

(b) Voice-tone cue: On nine occasions two teachers used their tone of voice as a cuing strategy. They did this in two different ways. One way was that the teacher would indicate that a certain answer was the required one. In the following instance,

> "Mmm, well let's have a little vote on it. Who thinks perhaps igneous rocks would be fairly hard rock?"

the teacher conveyed the impression with his voice that this was what he thought, and no child voted against it.

On eight out of the nine occasions the teachers' voice tone was used to indicate to a child that the teacher thought that the child's answer was wrong. In other words, the cuing strategy was directed toward extinguishing children's alternative answers. For example, when a girl said that the ligament was 'fat' during the lesson on bones the teacher responded,

> "Ooooh Nicole."

and added, to the other children,

> "Tell her what it is."
>
> (J.1 teacher)

During one of the lessons on rocks a girl guessed that a piece of sandstone/mudstone was a metamorphic rock and the teacher responded,

> "Ooooh, you think it's metamorphic do you? (Some children laugh) You disagree with him? (referring to a boy who had said 'sedimentary')."

to which the girl replied,

> "Oh, I agree."

(c) Right-path cue: A third strategy used by two teachers on four occasions encouraged children to persist with a certain line of thought that could lead to the answer that the teacher had in mind. For example, during the same lesson on rocks mentioned above, a child said that rocks which were washed down a stream would change into big and small, and the teacher tried to shape this further by saying,

> "Mmmm, you're actually on the track of something I want."
>
> (S.3 teacher)

(d) Closure cue: This strategy, which involved the teacher closing a discussion or teacher-question, children answering session as soon as a predetermined answer was heard, also had the effect of removing status from children's alternative answers. This strategy was used on at least six occasions by two of the teachers. During the lesson on bones, for example, the teacher recalled a recent suitcase-carrying episode and asked what had been happening to the children's arms. Various children called out, "pulling", "stretching", but as soon as one child said,

"Your muscles helping you.'

the teacher responded,

"That's right."

(J.1 teacher)

This can be contrasted with a third teacher who didn't use closure but instead encouraged the children to think of alternative answers. An instance occurred during the lesson on liquids when the word 'container' came up. The teacher said,

"Container's the word I was thinking of but has anyone got another good one?"

(S.1 teacher)

5. Children's Explanations Were Explored, Alternatives Sought, Extended, Evaluated, Ignored or Rejected

There were six main ways that the teachers dealt with the children's explanations and ideas that arose in the course of the lessons. These ranged from positively exploring the children's explanations in many instances, through to rejecting some of them. Some of the techniques have been alluded to in the previous section.

(a) Exploring: There were eighteen instances of the four teachers exploring what children meant by a particular explanation, idea, or word. For example, during the activity on water one child commented that the water surface was rounded and the teacher asked,

"Why do you think it's like that?"

(S.4 teacher)

In the course of the lesson on liquids a child said that a little blob of water could not be seen so clearly because it was 'separating' and the teacher asked supportively,

> "Separating? Was that the same as spreading out? What do you mean by separating? Was it going into more than one blob?"
>
> (S.1 teacher)

A further example is from one of the lessons on rocks where a child predicted that a certain rock would dissolve in water, to which the teacher responded,

> "It will dissolve. That's a good word isn't it. What does it mean, Dean?"
>
> (S.3 teacher)

(b) Seeking Alternatives: Two of the teachers sought alternative views from the children but this occurred on only two occasions. The following situation was one of those occasions. When one child explained how he thought sedimentary rocks formed, the teacher turned to another child and asked,

> "How does that sound Geoff?"
>
> (S.3 teacher)

(c) Extending: There were five instances where one teacher extended explanations given by the children. For example, when a child observed during one lesson on rocks that there was iron sand at the bottom of a jar used for a sedimentation activity the teacher added,

> "This was fairly coarse sand. Could we describe it a coarse sand?"
>
> (S.3 teacher)

(d) Deciding which is best: Apart from those occasions on which teachers effected closure to indicate which answer was the best, there was also an instance of a teacher telling the children which was the better explanation.

> "Now listen to Becky's answer because I think it's a better one than James'."
>
> (J.1 teacher)

(e) Ignoring: If a child's explanation did not match the idea that the teacher had in mind then it would perhaps be understandable if the teacher did not respond to the child. However, this was rarely the case in the lessons observed, although during the lesson on bones there were two occasions when the teacher ignored a child's idea which was clearly spoken. The following shows how it occurred the first time.

Teacher: "Remember when we were having maths the other day and we had to carry that heavy suitcase. What were the muscles doing then?"

Child: "Lifting."

Teacher: "They were (pauses, waiting for response to cue) ... Come on, you know, you couldn't carry that suitcase could you. You bent over ..."

(J.1 teacher)

In this particular instance it was not clear to the observer what response the teacher was seeking after the child's idea of 'lifting' was not accepted.

(f) Rejecting: When a teacher's aim is to ensure that children learn specific knowledge there will obviously be a concern on the part of the teacher to get rid of children's notions which are perceived to be false. As previously described, two teachers used their tone of voice on eight occasions to achieve this by rejecting children's ideas or explanations.

6. Children Meanings for Words Were Assumed to be Correct

A busy teacher has to make many rapid decisions in the course of a teaching day. One area in which decisions are required is children's meanings. A teacher must decide which meanings to explore and when to assume mutual understanding.

Reference was made to the teacher who explored the child's idea of 'dissolve'. On four other occasions the same teacher accepted words without questioning whether the child might have a meaning for those words which differed from the teacher's idea of them. For example, when one child predicted that a certain rock would 'disintegrate' the teacher repeated what the child had said and added endorsement.

"Disintegrate, I like that."

(S.3 teacher)

It is possible, however, that the children's meanings of the words referred to had been explored with them previously.

CHILDREN LEARNING SCIENCE

In the course of the science lessons the children responded in a number of different ways.

1. Children's Questions

The impression gained by the observer was that the children, especially the younger children, questioned the unusual. In the J.1 and S.1 classes, for example, at least twelve children asked the observer what the tape recorder was, or what it was doing.

"What's that you've got?"

(J.1 child)

The S.1 children who called out 'shell', 'frog', 'birds' and 'water' (see p.13) at the beginning of the lesson on liquids were also questioning the unusual, and the two J.1 children's questions of the bone produced by their teacher,

"What was it?"

"Is it off an animal?"

were in the same category.

In questioning the unusual these children acted in a way that was consistent with British 11 year old children (Harlen et.al., 1981) in that differences rather than similarities between objects or events caught their attention. Donaldson (1978) also mentions that the changing features of things tend to attract children's attention.

Apart from those questions mentioned above, the children asked few other questions during the whole of the six lessons. Only two others were verbally addressed by children to the phenomena under study. A J.1 child asked the teacher about the ligament,

"Can you break it?"

and a S.4 child asked himself a question,

"I wonder how thick water is?"

Another S.4 child questioned the basis of a peer's knowledge that water has a skin on it by asking,

"Who told you that?"

There were also two instances in the S.4 group task on water of the task requirements being questioned. At one stage, for example a child said,

"We're getting off the point."

and another asked,

"Well, what do you want to find out?"

There were also two instances of children questioning an adult who was present. A S.4 child spoke about skin forming on water and when the observer asked how it did that the child responded,

"What do you mean?"

The second occasion was during the lesson on bones when a child appeared in front of the observer with a lower jaw bone and asked the observer,

"Can you wiggle these teeth?"

(J.1 child)

In contrast to this paucity of questions asked by children of the content being studied, in a normal classroom, children can generate questions when invited to do so. A group of S.3/4 children generated nine questions about tree bark at the beginning of the lesson taken by one of the Project team members (Symington, Osborne, Biddulph and Freyberg, 1982). In this lesson children were specifically invited to suggest questions they would like answers to.

2. Children's Explanations

(a) Children generate ideas: In all the lessons observed the children generated many ideas and explanations. This was particularly so when the children worked in groups where they had a greater opportunity to pursue aspects that interested them. The discussion of the S.4 group involved in the water activity, for example, was rich in ideas and explanations as the following conversation indicates. The children had generally agreed that the water surface was covered by a 'skin'.

Child: "The skin of the water is still joined somewhere. See, it's probably joined anywhere."

Another Child: "Because when bubbles come up and they form over a circle like that, that's the skin. That's the air pressure of the skin coming up and making those big bubbles."

A third Child: "It isn't skin around the air (bubble). It's just air, it's just air, except that water's around it."

A further instance of children generating explanations is included to illustrate what children are capable of doing under favourable learning conditions. During the special lesson taken by one of the Learning in Science Project team members, and following small group discussions, the S.3/4 children suggested twenty-two explanations of why trees have bark (Symington, Osborne, Biddulph and Freyberg, 1982). This is consistent with a finding by Harlen et.al. (1981), namely that British 11 year old children showed flexibility in proposing alternative reasons that might explain given observations.

(b) Children generate predictions: There were twelve instances of children making predictions during the lessons observed. A common feature of these predictions was that they were made without hesitation by the children. This occurred whether they were made during children's group discussions, whether they were made in response to something the teacher did or said, or whether they were made in response to a teacher question. Three examples illustrate the three situations. The first example is of how the S.4 group predicted what would happen to the water in a container in front of them.

1st Child: "We could come back tomorrow and this water wouldn't be here because the sun would just (slight pause) bring it up."

2nd Child: "Evaporate it."

1st Child: "You could stay here all night and all day."

3rd Child: "No, no."

1st Child: "With a torch but you wouldn't see it go up."

3rd Child: "It wouldn't be all gone tomorrow, this water. It would take ..."

4th Child: "It would take about a week."

(S.4 children)

The second example is taken from the beginning of the lesson on liquids and shows how the children made spontaneous predictions in response to the teacher's introductory remarks.

Teacher: "I'm not going to tell you what the study is. I'm going to see if when I show you some things you can work out what it is about yourself."

1st Child: "Birds."

Teacher: "I said I'll show you something and I haven't showed you anything so how can you guess."

2nd Child: "Shells."

3rd Child: "Frog."

Other Children: (Call our various things but indistinguishable)

(S.1 children)

In the third example, taken from one of the lessons on rocks, the children responded to the teacher's question of what would happen if a certain rock was mixed with water. One child predicted,

"It will go all cloudy."

and another suggested,

"It will go into liquid."

(S.3 children)

On one occasion during the lesson on liquids three children became quite dogmatic about their own predictions. When they predicted that a substance in a sealed jar was golden syrup or oil, then for them it was that substance.

1st Child: "Hey, it's golden syrup."

2nd Child: "Oil."

3rd Child: "Yeah, it's oil."

(S.1 children)

(c) Children appear to enjoy giving explanations: The extent to which children generated explanations in group situations suggested that they found this an enjoyable activity. This was supported by the specific responses of two children. During one of the lessons on rocks when sandstone had been put into a jar partly filled with water the observer had a conversation with a child which ended in humour.

Observer: "I didn't think water would be able to seep into rock. Do you think that's what's happened?"

Child: "Mmm, or else it's leaked (laughs)."

(S.3 girl)

The other response was by a boy during the group work on water, and this was a boy whom the teacher later said had problems coping with formal classroom work. At one point he said,

"I'm running out of things to say."

and sometime later, as he tried to explain how he thought skin formed on water, he commented,

"I don't think, I don't know what I'm talking about here."

(S.4 boy)

He conveyed the impression to the observer though that he found it good fun trying.

(d) Some children have quite unique ideas: In the course of the six observed lessons there were twelve instances of children either threading together bits and pieces of knowledge to generate unique ideas or of children generating unique ideas on the basis of their immediate observations. During the

lesson on liquids, for example, one boy shook a jar of a particular liquid and saw that there were bubbles at the bottom. He tipped the jar upside down and noticed that the bubbles ended up at the bottom again but started rising to the surface which he still thought of as the bottom. The following is his descrption of what nappened together with his conclusion about the phenomena.

> "When it's upside down, the bubbles go down to the bottom and then start coming up to the bottom, up to the bottom, so that the bubbles always stay at the bottom of the liquid."
>
> (S.1 boy)

Another example comes from the lesson on water where a child integrated ideas of recycling and pollution. He said,

> "Water is just reused and reused. Pollution is formed out of water and then in the spring time it will melt again and go down the stream and it will just be reused and reused and reused."
>
> (S.4 boy)

At the new entrant level one child said that a particular piece of bone could bend,

> "Because it's getting a bit soft and old."
>
> (J.1 child)

3. Communicating Ideas

(a) Children appear keen and interested to share ideas: The spontaneous way in which children communicated their ideas and explanations to others, especially in group situations, suggested to the observer that the children had a strong desire to communicate such ideas and explanations. Frequently the communication was with other children as the following conversation by a group of S.4 children illustrates. They discussed whether there was any skin on the water.

1st Child: "When the water's calm it's there but when you touch it the skin breaks."

2nd Child: "No, the skin's there."

1st Child: "I know, but when you touch it like that (demonstrates) it breaks."

3rd Child: "When you put your hands in (does so) see the hairs on your arm, it pushes your skin and you see little jag, jigs. Um, the hair's pushing through the water."

(S.4 children)

During one of the lessons on rock a girl drew the observer's attention to the decreasing water level in a jar that contained sandstone.

"It's shrinking. I filled it up to there and now it's down there." (pointing to lower mark on container)

(S.3 girl)

There were also eleven instances of the children spontaneously communicating their ideas to their teacher or to the observer. One of the S.4 children, for example, drew the teacher's attention to a phenomenon to do with water that the child had discovered.

"Do you notice that when you push it down like that, no water gets inside." (pushes inverted measuring glass into water)

(S.4 child)

Nine of the eleven instances were of the younger children (J.1 - S.1) communicating information. For example, as the J.1 teacher tried to cut a ligament from a bone, one of the children told her,

"Our dad would be able to do it easily because he's got a real sharp knife."

(J.1 child)

During the lesson on liquids one child said to the observer,

"This one smells funny."

(b) Children use words in their own way to explain their ideas: There were occasions during the lessons when the words used by children to explain things could be misinterpreted by observers who were unaware of the particular feature(s) of a situation that the children were referring to. For example, during the lesson on liquids, a child looked at a drop of liquid which had been placed on a clear container lid and said,

"This is getting bigger."

(S.1 child)

The word 'bigger' was used by the child to explain how the substance spread out in this instance. Likewise, the word 'flat' was used by three children to describe the shape of the droplet which they viewed through the side of the container.

Observer: "What shape were they when you looked through the side of them?"

Child: "It was a little bit flat."

Another Child: "That one's flat." (pointing)

3rd Child: "Hey, look it's flat."

The children focussed on only part of the droplet, the bottom, whereas subseuqent discussion revealed that the teacher thought that the children would focus on the dome shape.

4. Changing Ideas

(a) Children's ideas are quite firmly held: If the children held an idea about some phenomenon then they were usually quite definite about that idea. Few expressed ideas in tentative form. In fact only three ideas and explanations observed during the lessons, could be called tentative. Two of these occurred during the group discussion on water. When several children were discussing 'how skin is made from water' one child suggested,

"It's got something to do with the water molecules."

(S.4 child)

A little later when they were wondering about why skin forms on hot milk one child pondered,

"Maybe it's the heat."

(S.4 child)

(b) Children don't critically reflect on their ideas: In the course of the science lessons the children were not observed to critically reflect on their ideas apart from one instance where a child recognised the basis of an explanation proposed by members of a group. This occurred during the special lesson on bark.

1st Child: "What shall we say?"

2nd Child: "Protects the wood."

3rd Child: "Bark is to, um, protect the trees."

4th Child: "Because how do we know? It'a a good guess, that's all."

(S.3/4 children)

This recognition was not incorporated into the group's explanation, however, as less than a minute later another child converted the group to a firm statement of explanation.

1st Child: "Yeah, we can put this: say 'bark is'.

2nd Child: "We think bark is to protect."

1st Child: "Not 'we think', 'bark is'."

The fact that there was only one instance of such recognition is consistent with another finding by Harlen et.al. (1981), namely that there was little critical reflection by 11 year old British children on the procedures they chose to use.

(c) Children can have their ideas changed by peers: There were few instances when a child's idea was questioned or challenged by other children but on four occasions this was observed to happen. One of these occurred during the lesson on bones when the teacher said that she was about to cut out the ligament.

1st Child: "Then it won't be alive any more."

Teacher: "No, it's not alive any more."

2nd Child: "It wasn't even alive then."

(J.1 children)

Another example, this time from the lesson on liquids, illustrates how on at least two occasions the challenge took the form of a direct contradiction. A group of children was discussing whether or not it was possible to see through a liquid.

1st Child: "I can see through it."

2nd Child: "No, I can't."

1st Child: "Yes, I can. I can see you."

2nd Child: "No, you can't really."

1st Child: "I can in the light."

2nd Child: "You can't really."

(S.1 children)

When children's ideas were challenged by others, or when children perceived that their ideas were disputed, they responded in several different ways. The following conversation shows how one child modified an idea in a group discussion during the special lesson on bark. He shifted his position from claiming that all trees of a certain kind lack bark to claiming that some of them lack bark.

1st Child: "No, you know (unclear) sort of trees? They don't have bark."

2nd Child: "They do so."

1st Child: "Some of them don't."

(S.3/4 children)

Another child responded by extending an explanation. This occurred during the lesson on water in which the children were discussing how skin forms on water. The child in question referred to the 'great huge skin' on the sea which 'forms back into the same place as it was before' if anything breaks it open.

5. Understanding Things

(a) Comparing: During the lessons observed, children made extensive use of comparison to understand the phenomena being studied. There were twenty-one instances of this. For example, water droplets were likened to dome-shaped 'cyclo' ships landing on a hill (S.1 child), golden syrup felt like squashy mud (S.1 child), the skin on water was described as a thick, layery thing (S.4 child) and bones were likened to the letter 'L' and were said to bend like a bow and arrow (J.1 children). On the other hand, there was only one instance of contrast being used to discuss ideas. Some of the S.4 children involved in the water activity explored the shape that water took when placed in a container. One child decided that the shape of the container determined the shape of the water and another child, using a contrasting situation, explained further,

> "But if you stick it on the ground it just splatters everywhere."
> (S.4 child)

(b) Associating: There were three occasions in the lessons observed when children communicated ideas which occurred to them through a process of associating something that happened during the lesson with some aspect of their experience. For example, when the J.1 teacher mentioned that the raw bone came from a hogget one child said,

> "I know because we've got a hogget and we selled it."
> (J.1 child)

6. Answering Strategies for Teachers' Questions

The children used five different answering strategies in the course of the lessons observed.

(a) Guess: There were three instances of children guessing at the response required by the teacher. For example, when the J.1 teacher asked a boy what he had learnt during the lesson on bones the following exchange occurred:

J.1 Boy: "The names of bones."

Teacher: "No, you didn't do names of bones today. That was the other day."

(b) Replication: Replication is a strategy by which one or more children imitate or repeat an answer just given by another child (MacLure and French, 1980). There were nine instances of replication, all by the younger children (J.1 - S.1) during the lessons on bones and liquids. For example, right at the beginning of the lesson on bones when the teacher placed a cattle skull in the middle of the circle of children and asked them what it was, the word 'cow' was repeated by at least three children.

Child: "A cow."

Teacher: "A cow what?"

Another Child followed by several others: "A cow ..."
"A cow ..."
"Cow ..."

(c) Retrieval: When children use a retrieval strategy to provide an answer they may recall to the situation a word, phrase or idea that occurred earlier in a lesson which they think might be relevant (MacLure and French, 1980). There were fifteen instances of retrieval by children during the lessons observed. For example, in the course of one of the lessons o n rock the teacher asked where limestone would be found and the conversation which followed included an instance where one child retrieved the name 'Taumarunui'.

1st Child: "Taumarunui."

Teacher: "Not quite as far south as Taumarunui."

2nd Child: "Waitomo."

Teacher: "Waitomo. Where's Waitomo?"

2nd Child: "Don't know."

Teacher: "Down around." (pauses, waiting for children to take cue)

3rd Child: "Taumarunui."

(S.3 child)

(d) Pseudo explanation: The observer noted three occasions on which children replied to a teacher enquiry using a form of words that indicated to the teacher that the children were more or less on-course with their task whereas they were not really on course. For example, during the lesson on bones the teacher asked whether the children thought bones were living things. Several children replied and one girl whom the observer had been watching gaze across the room at something else, play with her jeans, and who it would appear hadn't really heard the teacher's question, raised her hand and said,

"If they didn't have bones they would die."
(J.1 girl)

which was sufficiently related to the topic for the teacher to remain unaware that the girl's behaviour had been off-task prior to her 'answer'.

A second example is taken from the S.4 group work on water. Late in the lesson the teacher approached the group and enquired about the children's findings concerning a question that she had set them on a card.

Teacher: "Right, did you measure any water out into different containers and see what ..."

Child: "Yes, these two here."

Teacher: "Did they hold the same?"

Child: "Yes, and it is different shapes because this is round and that's triangular. Well it's really part of a circle."

No measurement had been done before the teacher arrived so the child didn't really know whether the containers held the same amount or not.

(e) Private view replaces group view: There were two instances during the lesson on liquids when S.1 children, who were reporting their groups' ideas to the teacher, reported something other than the group view. At one point when the teacher asked a child what the group thought the colour of the liquid was the child replied,

"A dark kind of marmalade colour."

a description which the group had never mentioned in its discussions. A little later when the teacher asked a girl whether the liquid was thick or thin the girl promptly replied,

"Thin."

although members of her group had previously disagreed as to whether it was thick or thin. The teacher, unaware of what had occurred in the group, accepted 'thin' as the group's view and passed on to the next feature.

7. Working Strategies When Doing Activities

(a) Children sometimes substitute their own tasks for the ones required by the teacher: Occurrences of off-task behaviour by some pupils are to be expected in any lesson and these lessons were no exception. There were at least twelve occasions during the lessons observed when children substituted their own tasks for those required by the teacher. The presence of an observer did not assist in this respect either. For example, during the lesson on bones a J.1 boy appeared beside the observer at one stage holding a vertebra and said,

"I can see you."

as he peeped through the largest hole. During the same lesson another boy spent fifteen minutes or so intermittently clicking two bones together, and a group of four children explored or played with the teacher's carving knife case for several minutes. However sometimes the tasks pupils generate would appear to provide the probability of worthwhile learning. Perhaps the best example of such an alternative task construction was that of the S.4 group studying water in which they moved right away from the requirements of the teacher's question card and explored the effects of pushing an inverted medicine glass under water.

(b) Involvement and appearance may outweigh thinking things out: When the observer arrived to see the lesson on pulleys the teacher said that the girls didn't usually get involved in the activities as much as the boys. However, the group of S.4 girls observed on that visit showed extensive and consistent involvement in the task using pulleys. The same was true of the S.4 group investigating water and the S.3 groups working on rocks.

There were five instances of the younger children (J.1 - S.1) actively exploring the features of things, especially things that were unusual, such as the observer's tape recorder, or things that moved, such as the teeth on the jawbone or the bubbles in the liquid.

A special feature of the involvement of the S.4 children working on the pulleys and water activities was their instant action. For example, when one girl suggested that cellotape was needed to attach string to a weighted paper bag so that a pulley could be hooked to it, another girl rushed off to get cellotape before a third could finish expressing her view that cellotape wouldn't be strong enough for the task. An example from the water activity involved the children tipping water in and out of containers before they were really clear what the task required of them.

1st Child: "Tip all the ..."

Observer: "So what are you really trying to find out?"

2nd Child: "We're going to find out if they ... what are we trying to find out?"

3rd Child: "If different shapes, if different shapes amounts of water."

2nd Child: "Measure it, measure it."

3rd Child: "Five and forty."

Observer: "You're trying to find out different ..."

1st Child: "Put it on the ground, put it on the ground. It's shaking around, see."

3rd Child: "It's five cups, five cups."

Donaldson (1978) comments on the fact that children may be dominated by the look of things. There were at least five instances in the lessons observed where the appearance of a phenomena dominated a child's thinking. During one of the lessons on rocks, for example, the observer sought a child's explanation but the child responded with further observations.

Observer: "Is that some bubbles still coming now?"

Child: "Yeah, yeah."

Observer: "How could they be coming from inside the rock."

Child: "There's some coming out there." (pointing)

Observer: "Yes, why is that?"

Child: "There's some on the side ... (pause as child observes further). It's getting all loose." (edge of rock in water)

A similar thing happened during the lesson on bones. The observer enquired about a raw bone that a J.1 child was holding.

Observer: "What does it smell like?"

Child: "That little thing (touches slippery ball of bone end) you feel it." (holds for observer to feel)

(c) Execution of written or diagrammatic instructions is sometimes difficult: There was one occasion during the lessons observed when some children had problems constructing apparatus from a diagram. Actually it was a picture of an arrangement of two pulleys and cord. During the half hour or so that the observer spent with a group of six involved in the activity they did not succeed in reproducing the arrangement with the apparatus that they had. In fact they confused themselves by introducing extra pulleys and engaging in an 'instant-action' approach, as already described.

Whether this was an example of 'arbitrary error' in that the children ignored part of the information given while acting on the rest, or whether it was an example of 'executive error' in that they failed to carry out the manipulation required as a result of an overload of information (Donaldson, 1963) is not known.

(d) Children tend to ignore variables: There were instances of children ignoring variables in the course of the science activities observed. This occurred at least four times. In the pulleys activity, for example, the S.4 girls made no attempt to pull the load without using pulleys as a

comparison with the weight when using pulleys. This particular instance may also be an example of what Donaldson (1963) calls 'structural error' where children fail to comprehend the meaning or implication of the task or content.

A further example came from the lesson on bones where a J.1 child decided that a bone came from a particular animal by ignoring the fact that other animals have a similar attribute.

Child: "A dog."

Observer: "A dog's bone? Why do you think that?"

Child: "Because dogs can move their legs."

This again is consistent with a finding by Harlen et.al. (1981), namely that the performance of 11 year old British children was low in controlling variables if there were several to be considered.

(e) Few children suggested that reference material should be used to find answers: Of all the children observed only one expressed a desire to use reference material to find an explanation. The occasion was the special lesson on bark with the S.3/4 class. A boy was trying to find some reasons for why trees have bark and said,

"If we had some books on bark, and research books."

SUMMARY:

The observations reported in this paper confirm earlier data (Biddulph, 1982) which indicated that teachers perceive their role in primary science teaching as one of transmitting knowledge to children. The observed teachers chose the knowledge from the departmental science units and used a variety of strategies to try to transmit this to the children. The strategies included involving the children in certain practical activities to answer teacher-generated questions, engaging them in teacher-questioning/children-answering sessions, the use of a number of cuing techniques, and the elaboration of some children's 'correct' answers. In pursuing these strategies, the teachers tended to accept that the children were using words

in the way that the teachers understood them and further, there was little attempt by the teachers to link new knowledge to ideas that the children might already hold. On some occasions in fact children's attempted explanations were either ignored or rejected. When their attempted explanations seemed to match the answers that the teachers had in mind, however, the teachers tended to seize upon them and elaborate them into fully 'acceptable' answers. On the other hand, there were also times when some of the teachers genuinely explored children's explanations or sought other children's views. With respect to problems and activities the data suggests that the science problems posed by the teachers for the children, mainly by way of questions, tended not to become the children's problems and likewise, the activities arranged by the teacher for the children did not necessarily become the children's activities. Nothing really new is being proposed by this as Tasker (1981) reported the existence of these two problems at the F.1-4 level as previously mentioned.

One of the effects of the use of the teaching strategies mentioned above, which Harlen et.al. (1977) call a 'closed' approach, was that the children tried to find out the answers that the teachers had in mind. In this respect their response was similar to that of students in F.1-4 science classes (Tasker, 1981). Barnes (1976) has described the same effects on children in England. The children tried to find the teacher required answers by using a number of strategies of their own such as guessing, retrieving something that had been said earlier and replicating what may have been the correct answers of other children. In doing this they hardly ever asked questions during lessons and tended not to reflect upon their ideas or ways of doing things. The observations suggested that the children generated ideas which they then held in a rather definite manner, although there were a few instances where they modified these in the face of peer challenge. They expressed almost no desire to consult reference material.

However, it does appear that children can generate ideas and predictions, some of which are quite unique. They also seem to enjoy doing so and show a keenness to communicate these ideas to others, sometimes using a form of words which is also unique.

In their work the children used a number of strategies other than those described above. They made extensive use of comparison or analogy to try to understand things and some use of association. There was evidence of them substituting their own tasks for teacher-given tasks and they coped with some situations by ignoring some of the relevant variables. Their critical thinking tended to be overwhelmed by the appearance of, or their desire to be actively involved in, other situations. Translating written or diagrammatic instructions into actual tasks seemed to pose special difficulties for them.

TOWARD RETHINKING OUR APPROACH TO TEACHING

The approach used by the teachers will not strike those familiar with teaching in New Zealand as unusual. Indeed it is a well-used teaching model that is employed in most curriculum areas. In all likelihood it provides primary teachers of science with a reasonably secure teaching structure in an area where many lack confidence. There is no question that the primary teachers, who taught these lessons, are experienced and conscientious teachers. They have well developed teacher skills and obvious commitment to children.

In our view, the common teaching model used may well result in some problems as far as children's learning in science is concerned. The communication system established by teachers using this model carries embedded in it the notion that knowledge is something that is received from an authority rather than something that students construct for themselves. The 'language for performance' approach used by the teachers did not usually encourage the children to reflect upon or recode their own experiences. If they did it was not necessarily in the direction intended by the teacher, although some of the children's verbalisations in the presence of the teacher may have suggested otherwise. To use a distinction made by Barnes(1976), it is likely that for many children school science knowledge remained separate from their 'action' knowledge, that is, from the ideas and beliefs that form the basis of their everyday actions. Such a distinction has certainly been identified in older children (Gilbert, Osborne and Fensham, 1982).

In our view the above analyses of classroom interactions raise certain questions. These questions include:

i) Are there real and important difficulties in teaching and learning associated with the issues outlined?

ii) Do the issues raise questions about the aims of science teaching?

iii) Do we have to be clear about our aims of science teaching before we can decide what real difficulties are associated with the issues?

iv) If there are difficulties with aspects of our teaching in terms of particular aims how can these difficulties be overcome?

In terms of the future direction of LISP(P) research, such questions will need to be faced and the implications for research considered.

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